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(54) **Helmholtz resonance silencer**

(57) The present invention provides a Helmholtz resonance silencer capable of further improving its silencing effect without deviation of its resonant frequency from the frequency of sound to be silenced. The present invention is a Helmholtz resonance silencer including: a body having a cavity part (SC) therein; and a communication hole (18a) for communication between the cavity part (SC) and an outside of the body. The communication hole (18a) has a cross-sectional profile other than a precise circle so as to increase viscous resistance generated between the vibrating air in the communication hole (18a) and the surface defining the communication hole (18a).

FIG.5A

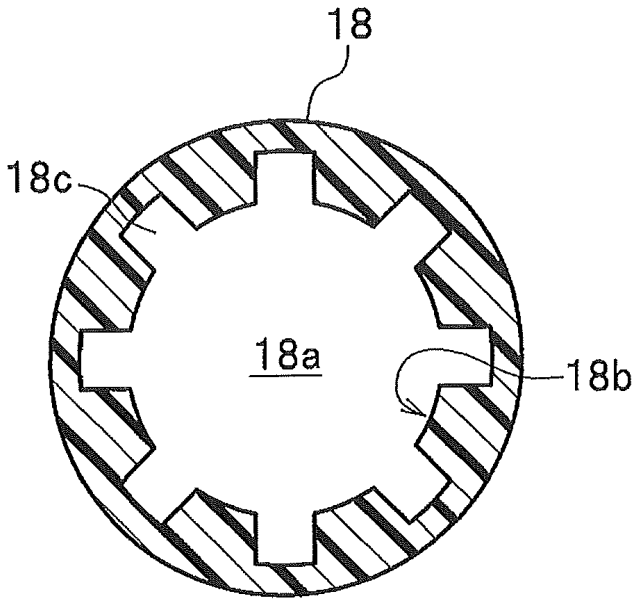

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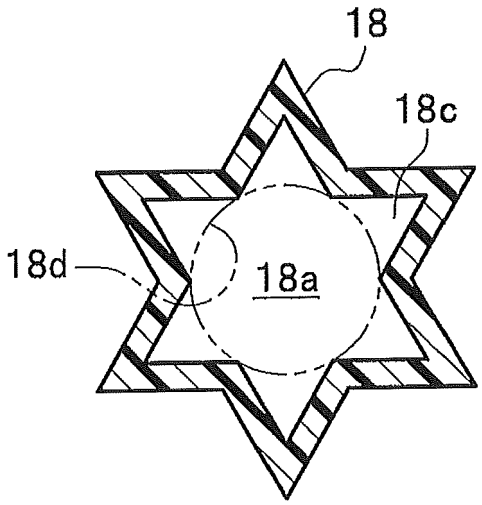
FIG.5B



Description

TECHNICAL FIELD

[0001] The present invention relates to a Helmholtz resonance silencer.

BACKGROUND ART

[0002] Conventionally, there has been known a Helmholtz resonance silencer having a cavity part (also referred to as additional chamber) and a communication hole for communication between the cavity part and the outside (for example, refer to Patent Document 1). This Helmholtz resonance silencer constitutes a vibration system, in which air in the communication hole serves as a mass and an air in the cavity part serves as a spring, if they are compared to components of the vibration system. If a sound of the same frequency as the natural frequency of the vibration system propagates into the cavity part through the communication hole, a resonance is triggered in the Helmholtz resonance silencer and the air in the communication hole vibrates intensely. The Helmholtz resonance silencer silences the sound by damping the resonance with viscous resistance generated between the vibrating air in the communication hole and the surface defining the communication hole.

[Prior Technical Document]

[Patent Document]

[0003] [Patent Document 1] Japanese Patent Application Laid-Open Publication No. 2012-51397

SUMMARY OF THE INVENTION

Technical Problem

[0004] Meanwhile, one may consider making the cross-sectional area of the communication hole larger or making the length of the communication hole longer in order to improve the silencing effect of the Helmholtz resonance silencer. However, if the cross-sectional area or the length of the communication hole is set to a large size, there is a problem that the resonant frequency (f_0) of the Helmholtz resonance silencer deviates from the frequency of sound to be silenced, as can be appreciated from the next formula (1).

$$f_0 = C/2\pi \times \sqrt{(S/V(L+\alpha \times \sqrt{S}))} \qquad \text{(formula 1)}$$

where:

f_0 (Hz) is a resonant frequency;
C (m/s) is a sound speed in the cavity part;
V (m^3) is a volume of the cavity part;
L (m) is a length of the communication hole;
S (m^2) is a cross-sectional area of the communication hole; and
α is a correction coefficient.

[0005] Thus, the purpose of the present invention is to provide a Helmholtz resonance silencer capable of further improving the silencing effect without deviation of the resonant frequency from the frequency of sound to be silenced.

Solution to Problem

[0006] The present invention has solved the above problem, and is characterized in a Helmholtz resonance silencer comprising: a body having a cavity part therein; and a tube including an inner circumferential surface defining a communication hole communicating between the cavity part and an outside of the body, wherein the communication hole has a cross-sectional profile other than a precise circle.

[0007] Moreover, in such a Helmholtz resonance silencer, it is preferred that the cross-sectional profile of the communication hole includes at least one irregularity (in other words, recess or indentation).

[0008] Furthermore, in such a Helmholtz resonance silencer, it is preferred that the cross-sectional profile of the

communication hole is defined by an outer periphery of a combinational shape of a circle and at least one protruding portion protruding outward from the circle, the at least one protruding portion corresponding to the at least one irregularity.

[0009] Still further, in such a Helmholtz resonance silencer, it is preferred that the at least one irregularity is shaped in a groove extending in a longitudinal direction of the communication hole, so as to twist about a center of a cross-sectional profile of the communication hole along the longitudinal direction of the communication hole.

[0010] The above Helmholtz resonance silencer increases the viscous resistance generated between the vibrating air in the communication hole and the surfaces of the communication hole, without changing the cross-sectional area of the communication hole or the length of the communication hole.

Advantageous Effects of Invention

[0011] According to the Helmholtz resonance silencer of the present invention, the viscous resistance generated between the vibrating air in the communication hole and the surface defining the communication hole is increased without changing the cross-sectional area or the length of the communication hole. Thus, the silencing effect is further enhanced without deviation of the resonant frequency from the frequency of sound to be silenced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1 is a perspective view of a vehicle wheel provided with additional air chamber members as a Helmholtz resonance silencer according to an embodiment of the present invention.
FIG. 2A is an overall perspective view of the additional air chamber member of FIG. 1.
FIG. 2B is an overall elevational view of the additional air chamber member of FIG. 1.
FIG. 3 is a partially enlarged cross-sectional view, taken along line III - III of FIG. 1, of the additional air chamber member disposed on the well portion of the vehicle wheel of FIG. 1.
FIG. 4 is a perspective view showing the additional air chamber member cut off along line IV-IV of FIG. 2A.
FIG. 5A is a cross-sectional view of a tube body with a communication hole in the additional air chamber member.
FIG. 5B is a cross-sectional view of a tube body according to an exemplary variant.
FIG. 6 is a perspective view of a communication hole according to another exemplary variant.

DETAILED DESCRIPTION

[0013] Next, an embodiment of the present invention is described in detail with reference to drawings when needed.

[0014] FIG. 1 is a perspective view of a vehicle wheel 1 equipped with a Helmholtz resonance silencer (hereinafter, referred to as additional air chamber member 10) according to the embodiment of the present invention. This additional air chamber member 10 serves to reduce road noises originating from air column resonance in a tire air chamber.

[0015] In the embodiment of the present invention, the additional air chamber member 10 is mainly characterized in that a communication hole 18a is in the specific shape described below to enhance the viscous resistance generated between the vibrating air in the communication hole 18a and the surface defining the communication hole 18a (the inner surface of a tube body 18 described below (refer to FIG. 2)).

[0016] First, the overall structure of the vehicle wheel 1 will be described here.

[0017] As shown in FIG. 1, the vehicle wheel 1 is provided with additional air chamber members 10 aligned at an interval in the wheel circumferential direction X. It is noted that, although four additional air chamber members 10 are provided in the present embodiment, two, three, five or more additional air chamber members may be provided according to the present invention.

[0018] In the present embodiment, the vehicle wheel 1 includes a rim 11 and a disk 12 for connecting the rim 11 with a hub (not shown). In FIG. 1, reference number 11d denotes an outer circumferential surface of a well portion 11c, into which the additional air chamber members 10 are fitted as will be described in detail below. Moreover, reference number 15 denotes an annular vertical wall standing on the outer circumferential surface 11d of the well portion 11c so as to extend in the circumferential direction of the rim 11. It is noted that the additional air chamber members 10 are engaged with and fixed on the vertical wall 15 as will be described below. Reference number 18 denotes a tube body having a communication hole 18a inside.

[0019] When the additional air chamber member 10 is fixed on the vertical wall 15, the tube body 18 is inserted into a cutout portion 15a of the vertical wall 15, and serves as a rotation stopper member for preventing an offset movement of the additional air chamber member 10 in the wheel circumferential direction X.

[0020] FIG. 2A is an overall perspective view of the additional air chamber member 10, and FIG. 2B is an elevational view of the additional air chamber member 10.

[0021] As shown in FIG. 2A and FIG. 2B, the additional air chamber member 10 is a member that is long in one direction (wheel circumferential direction X) and has a main body 13, a tube body 18, edge portions 14a, 14b, and extended portions 14c, 14d.

[0022] The main body 13 is formed so as to curve along the circumferential curvature of the outer circumferential surface 11d (refer to FIG. 1) in the longitudinal direction. As will be described later in detail, the main body 13 has an additional air chamber SC (refer to FIG. 3) inside. It is noted that this additional air chamber SC corresponds to the "cavity part" in the claims.

[0023] The tube body 18 is disposed so as to protrude from the main body 13 in the wheel width direction Y at the center portion in the longitudinal direction of the additional air chamber member 10.

[0024] Inside the tube body 18, there is formed a communication hole 18a having a length corresponding to the length of the tube body 18. This communication hole 18a serves to make the additional air chamber SC (refer to FIG. 3) inside the main body 13 in communication with the tire air chamber MC (refer to FIG. 3).

[0025] The shape of the communication hole 18a will be described in detail later.

[0026] The edge portion 14a and the edge portion 14b are formed along both sides in the wheel width direction Y of the main body 13, and extend in the wheel circumferential direction X. As will be described in detail later, these edge portions 14a, 14b are latched on respective groove portions 17a, 17b (refer to FIG. 3) of first and second vertical wall surfaces 16a, 16b (refer to FIG. 3) in order to secure the main body 13 in the well portion 11c, wherein the first vertical wall surface 16a is formed in the annular vertical wall 15 standing on the well portion 11c (refer to FIG. 1), and the second vertical wall surface 16b is formed in the well portion 11c so as to face the first vertical wall surface 16a in the wheel width direction Y.

[0027] The extended portion 14c and the extended portion 14d are such that a plate-like body portion extending in the wheel circumferential direction X from a wheel-circumferentially end portion of a later-described bottom plate 25b (refer to FIG. 3) of the main body 13 is formed integrally with a plate-like body portion extending in the wheel circumferential direction X from a wheel-circumferentially end portion of the edge portions 14a, 14b. It is noted that the extended portions 14c, 14d are disposed on the extension of the edge portions 14a, 14b in the wheel circumferential direction X, and curve along the circumferential curvature of the outer circumferential surface 11d (refer to FIG. 1).

[0028] Reference number 33a denotes a top-side joint portion described below (refer to FIG. 3).

[0029] FIG. 3 referred next is a cross-sectional view of the additional air chamber member 10 disposed on the well portion 11c, and a partially enlarged cross-sectional view taken along line III-III of FIG. 1.

[0030] As shown in FIG. 3, the main body 13 of the additional air chamber member 10 includes a bottom plate 25b and a top plate 25a for delimiting the additional air chamber SC therebetween. Although the top plate 25a and the bottom plate 25b have an identical thickness in the present embodiment, their thicknesses may differ from each other.

[0031] The top plate 25a curves so as to form a bulge above the bottom plate 25b disposed along the outer circumferential surface 11d of the well portion 11c, so that the additional air chamber SC is formed.

[0032] The top-side joint portions 33a are formed in the top plate 25a in the region of the main body 13. The top-side joint portions 33a are formed such that portions of the top plate 25a are depressed into the additional air chamber SC, and each have a circular shape in a plan view. As shown in FIG. 2A, ten top-side joint portions 33a are aligned on the center line of the main body 13 along the longitudinal direction of the additional air chamber member 10 (wheel circumferential direction X).

[0033] Returning to FIG. 3 again, bottom-side joint portions 33b are formed in the bottom plate 25b at places corresponding to the top-side joint portions 33a.

[0034] These bottom-side joint portions 33b are formed such that portions of the bottom plate 25b are depressed into the additional air chamber SC, and each have a circular shape in a plan view. These bottom-side joint portions 33b connect the bottom plate 25b with the top plate 25a by joining the tips of the bottom-side joint portions 33b with the tips of the top-side joint portions 33a.

[0035] It is noted that the present invention may be structured without the top-side joint portions 33a and the bottom-side joint portions 33b.

[0036] The edge portion 14a and the edge portion 14b connect the bottom plate 25b with the top plate 25a.

[0037] The tips of both the edge portion 14a and the edge portion 14b are fitted into the groove portion 17a of the first vertical wall surface 16a and the groove portion 17b of the second vertical wall surface 16b, respectively.

[0038] The edge portions 14a, 14b, which are fitted into and locked on the groove portions 17a, 17b of the first and second vertical wall surfaces 16a, 16b, are integrated with the aforementioned curved bottom plate 25b to form a curved surface that is convex toward the outer circumferential surface 11d of the well portion 11c. Also, the extended portions 14c, 14d (refer to FIG. 2) positioned on the extension of the edge portions 14a, 14b and the bottom plate 25b in the wheel circumferential direction X form a curved surface, not shown, that is convex toward the outer circumferential surface 11d of the well portion 11c.

[0039] In the present embodiment, the thickness of the edge portions 14a, 14b and the extended portions 14c, 14d (refer to FIG. 2) is set substantially identical with the thickness of the bottom plate 25b and the top plate 25a. The edge

portions 14a, 14b and the extended portions 14c, 14d have spring elasticity, by appropriately selecting their thicknesses and materials.

[0040] In the present embodiment described above, the additional air chamber members 10 are supposed to be resin moldings, however, it is not limited thereto, but may be made of other materials such as metal and the like. In the case of resin, it is preferred to use a lightweight, high-rigidity resin that is capable of blow molding, in consideration of reduction in weight, enhancement of mass productivity, reduction in manufacturing cost, securement of air-tightness of the additional air chamber SC, etc. Above all, polypropylene resistant to repetitive bending fatigue is particularly preferable.

[0041] Next, a rim 11 to which the additional air chamber members 10 are fixed will be described.

[0042] The rim 11 has the well portion 11c which is concave toward the inside (the rotation center) in the wheel radial direction between the bead seat portions of a tire (not shown) provided at both edge portions in the wheel width direction Y shown in FIG. 1.

[0043] The well portion 11c is provided for the bead portions (not shown) of the tire to be dropped thereinto when the tire (not shown) is assembled on the rim 11. It is noted that, in the present embodiment, the well portion 11c is formed in a cylindrical shape having a substantially same diameter across the wheel width direction Y.

[0044] An annular vertical wall 15 stands on the outer circumferential surface 11d of the well portion 11c so as to extend in the circumferential direction of the rim 11.

[0045] Returning to FIG. 3 again, the vertical wall 15 stands on the outer circumferential surface 11d with a first vertical wall surface 16a rising outward (upward in the sheet of FIG. 3, the same applies hereinafter) in the wheel radial direction from the outer circumferential surface 11d of the well portion 11c.

[0046] Also, the second vertical wall surface 16b is provided on the side face portion 11e disposed inside the well portion 11c in the wheel width direction Y (leftward in the sheet of FIG. 3), in such a manner that the second vertical wall surface 16b substantially faces the first vertical wall surface 16a. It is noted that, in the present embodiment, the vertical wall 15 is molded integrally with the well portion 11c when the rim 11 is casted.

[0047] The groove portion 17a and the groove portion 17b are formed in the first vertical wall surface 16a and the second vertical wall surface 16b, respectively. These groove portions 17a, 17b are formed along the circumferential direction of the outer circumferential surface 11d of the well portion 11c so as to form annular circumferential grooves. The edge portion 14a and the edge portion 14b of the additional air chamber member 10 are fitted into these groove portions 17a, 17b. It is noted that, in the present embodiment, the groove portions 17a, 17b are formed by machining the vertical wall 15 and the side face portion 11e, respectively.

[0048] FIG. 4 referred next is a perspective view showing a cross-section of the additional air chamber member 10 cut off along line IV-IV of FIG. 2.

[0049] As shown in FIG. 4, the top-side joint portion 33a and the bottom-side joint portion 33b are joined with one other in the additional air chamber SC, to increase the mechanical strength of the additional air chamber member 10, while also effectively performing a silencing function, described later, by suppressing fluctuation in volume of the additional air chamber SC.

[0050] The volume of the additional air chamber SC is preferably about 50 - 250 cc. By setting the volume of the additional air chamber SC within this range, the additional air chamber member 10 performs the silencing effect sufficiently, while also suppressing an increase in its weight to achieve weight reduction of the vehicle wheel 1 (refer to FIG. 1). Moreover, the length of the additional air chamber member 10 in the wheel circumferential direction X (refer to FIG. 2) can be appropriately determined in consideration of weight adjustment of the vehicle wheel 1 and easiness in assembling it into the well portion 11c, wherein one half of the circumferential length (the circumferential length of the outer circumferential surface 11d (refer to FIG. 1) of the well portion 11c (refer to FIG. 1)) of the rim 11 (refer to FIG. 1) is the maximum circumferential length of the additional air chamber member 10.

[0051] It is noted that, in FIG. 4, reference number 13 denotes the main body, reference number 25a denotes the top plate, and reference number 25b denotes the bottom plate.

[0052] Next, the shape of the communication hole 18a will be described.

[0053] In the present embodiment, the communication hole 18a is formed in the tube body 18 having a cylindrical outer shape as shown in FIGS. 2A and 2B.

[0054] FIG. 5A referred next is a cross-sectional view of the tube body 18 of the additional air chamber member 10, in which the communication hole 18a is formed.

[0055] In the present embodiment, the communication hole 18a is provided with groove-like irregularities 18c partially on the inner circumferential surface 18b of the tube body 18 as shown in FIG. 5A. To explain more specifically, the communication hole 18a has a cross-sectional profile which corresponds to the outer periphery of a combinational shape of "a circle portion defining the inner circumferential surface 18b" and "protruding portions corresponding to the irregularities 18c" (protruding portions protruding outward from the circle).

[0056] Although in the present embodiment the inner circumferential surface 18b is supposed to be an outer peripheral surface of a circular column shaped space disposed inside the tube body 18, the inner circumferential surface 18b may be an outer peripheral surface of an elliptical column shaped space.

[0057] Although in the present embodiment a plurality (eight in the present embodiment) of irregularities 18c are provided at an interval along the circumferential direction of the inner circumferential surface 18b, the number of the irregularities 18c may be one or more.

[0058] Although in the present embodiment the irregularities 18c have a rectangular cross-sectional shape, the cross-sectional shape of the irregularities 18c may be other shapes such as a polygon, a semi-circle, a semi-ellipse, etc, which are not a rectangle.

[0059] Also, although in the present embodiment the irregularities 18c are supposed to extend and continue over the longitudinal direction of the tube body 18, the irregularities 18c may be formed at intervals in the longitudinal direction of the tube body 18. Moreover, the irregularities 18c may extend either linearly or spirally (rifling shape) in the longitudinal direction of the tube body 18.

[0060] Moreover, although in the present embodiment the outer shape of the tube body 18 is supposed to be a circular column as described above, the outer shape of the tube body 18 may be an elliptical column.

[0061] Also, the outer shape of the tube body 18 may be designed in a shape similar to the cross-sectional profile of the communication hole 18a in the cross-sectional view.

[0062] FIG. 5B is a cross-sectional view of the tube body according to an exemplary variant.

[0063] As shown in FIG. 5B, the outer shape of the tube body 18 is similar to the communication hole 18a in a star shape in the cross-sectional view. Although the star shape shown in FIG. 5B is a six-rayed star shape (hexagram), the shape is not limited thereto, but can be other star shapes such as a five-rayed star shape (pentagram). In FIG. 5B, reference number 18c denotes irregularities (protruding portions), and reference number 18d denotes the circular portion described above.

[0064] The length and the cross-sectional area of the communication hole 18a are set to satisfy the next formula shown as "formula 1" for calculating a resonant frequency of a Helmholtz resonator.

$$f_0 = C/2\pi \times \sqrt{(S/V(L+\alpha \times \sqrt{S}))} \qquad \text{(formula 1)}$$

where:

f_0 (Hz) is a resonant frequency;
C (m/s) is a sound speed in the additional air chamber SC (i.e., a sound speed in the tire air chamber MC);
V (m^3) is a volume of the additional air chamber SC;
L (m) is a length of the communication hole 18a;
S (m^2) is a cross-sectional area of the opening of the communication hole 18a; and
α is a correction coefficient.

Note that the resonant frequency f_0 is adjusted to the resonant frequency of the tire air chamber MC.

[0065] Next, behavior and effects performed by the additional air chamber member 10 according to the present embodiment will be explained.

[0066] Generally, a Helmholtz resonance silencer (an additional air chamber member 10) damps and silences the aforementioned resonance using viscous resistance generated between the vibrating air in the communication hole 18a and the surface defining the communication hole 18a.

[0067] In the additional air chamber member 10 of the present embodiment, the communication hole 18a is formed with irregularities 18c disposed partially on the inner circumferential surface 18b of the tube body 18. Thus, the communication hole 18a has a larger surface area on the inner circumferential side as compared to a communication hole having a circular or elliptical cross-section of the same cross-sectional area as the communication hole 18a. That is, the contact area between the vibrating air in the communication hole 18a and the inner circumferential surface defining the communication hole 18a is increased without changing the cross-sectional area of the communication hole (S in the aforementioned formula 1, hereinafter the same applies) or the length of the communication hole (L in the aforementioned formula 1, hereinafter the same applies).

[0068] Therefore, in the additional air chamber member 10 of the present embodiment, the viscous resistance generated between the vibrating air in the communication hole 18a and the surface defining the communication hole 18a is increased. Thus, according to the additional air chamber member 10 like this, since the viscous resistance generated between the vibrating air in the communication hole and the surface defining the communication hole is increased without changing the cross-sectional area (S) of the communication hole or the length (L) of the communication hole as explained above, the silencing effect is further enhanced without deviation of the resonant frequency from the frequency of sound to be silenced.

[0069] Hereinabove, although the present embodiment has been described, the present invention is not limited to the foregoing embodiment, but may be embodied variously. In the additional air chamber member 10 of the present invention,

the contact area between the air in the communication hole 18a and the inner circumferential surface defining the communication hole 18a may be increased by shaping the communication hole 18a to twist spirally itself. FIG. 6 is referred next to show a perspective view of a communication hole according to another exemplary variant.

[0070] As shown in FIG. 6, a communication hole 18a is shaped to twist about the center Ax of the cross-sectional profile of the communication hole 18a. Although the present embodiment illustrated the twist of the communication hole 18a in which the cross-sectional profile twists 30° about the center Ax from one end to the other end of the communication hole 18a, in the present invention the additional air chamber member 10 may have a communication hole 18a twisting spirally more than or less than 30°. Although the cross-sectional shape (cross-sectional profile) of the communication hole 18a shown in FIG. 6 is a regular hexagon, the cross-sectional shape is not limited particularly thereto, as long as the cross-sectional shape is a shape other than a precise circle which renders the twisting ineffective (not precise circle). In FIG. 6, reference number 18 denotes a tube body, the outer shape of which is shown with imaginary lines.

[0071] Moreover, although in the foregoing embodiment the Helmholtz resonance sound absorber of the present invention was illustrated with, as an example, the additional air chamber member 10 for reducing road noises due to the air column resonance in the tire air chamber MC, the present invention may be utilized as a Helmholtz resonance sound absorber disposed at a suction pipe of a thermomotor such as an internal combustion engine, an external combustion engine and the like.

[Description of reference numerals]

[0072]

10: an additional air chamber member (Helmholtz resonance sound absorber)
11c: a well portion
11d: an outer circumferential surface of the well portion
13: a main body
14a: an edge portion
14b: an edge portion
16a: a first vertical wall surface
16b: a second vertical wall surface
18: a tube body
18a: a communication hole
25a: a top plate
25b: a bottom plate
X: wheel circumferential direction
Y: wheel width direction
SC: an additional air chamber (a cavity part)
MC: a tire air chamber

[0073] The present invention provides a Helmholtz resonance silencer capable of further improving its silencing effect without deviation of its resonant frequency from the frequency of sound to be silenced. The present invention is a Helmholtz resonance silencer including: a body having a cavity part (SC) therein; and a communication hole (18a) for communication between the cavity part (SC) and an outside of the body. The communication hole (18a) has a cross-sectional profile other than a precise circle so as to increase viscous resistance generated between the vibrating air in the communication hole (18a) and the surface defining the communication hole (18a).

Claims

1. A Helmholtz resonance silencer comprising:

a body having a cavity part (SC) therein; and
a tube (18) including an inner circumferential surface defining a communication hole (18a) communicating between the cavity part (SC) and an outside of the body,
wherein the communication hole (18a) has a cross-sectional profile other than a precise circle.

2. The Helmholtz resonance silencer according to claim 1,
wherein the cross-sectional profile of the communication hole (18a) includes at least one irregularity (18c).

3. The Helmholtz resonance silencer according to Claim 2,
wherein the cross-sectional profile of the communication hole (18a) is defined by an outer periphery of a combinational shape of a circle and at least one protruding portion protruding outward from the circle, the at least one protruding portion corresponding to the at least one irregularity (18c).

4. The Helmholtz resonance silencer according to Claim 2,
wherein the at least one irregularity (18c) is shaped in a groove extending in a longitudinal direction of the communication hole (18a), so as to twist about a center of a cross-sectional profile of the communication hole (18a) along the longitudinal direction of the communication hole (18a).

5. The Helmholtz resonance silencer according to Claim 1,
wherein the cross-sectional profile twists about a center of the cross-sectional profile along a longitudinal direction of the communication hole (18a).

FIG. 1

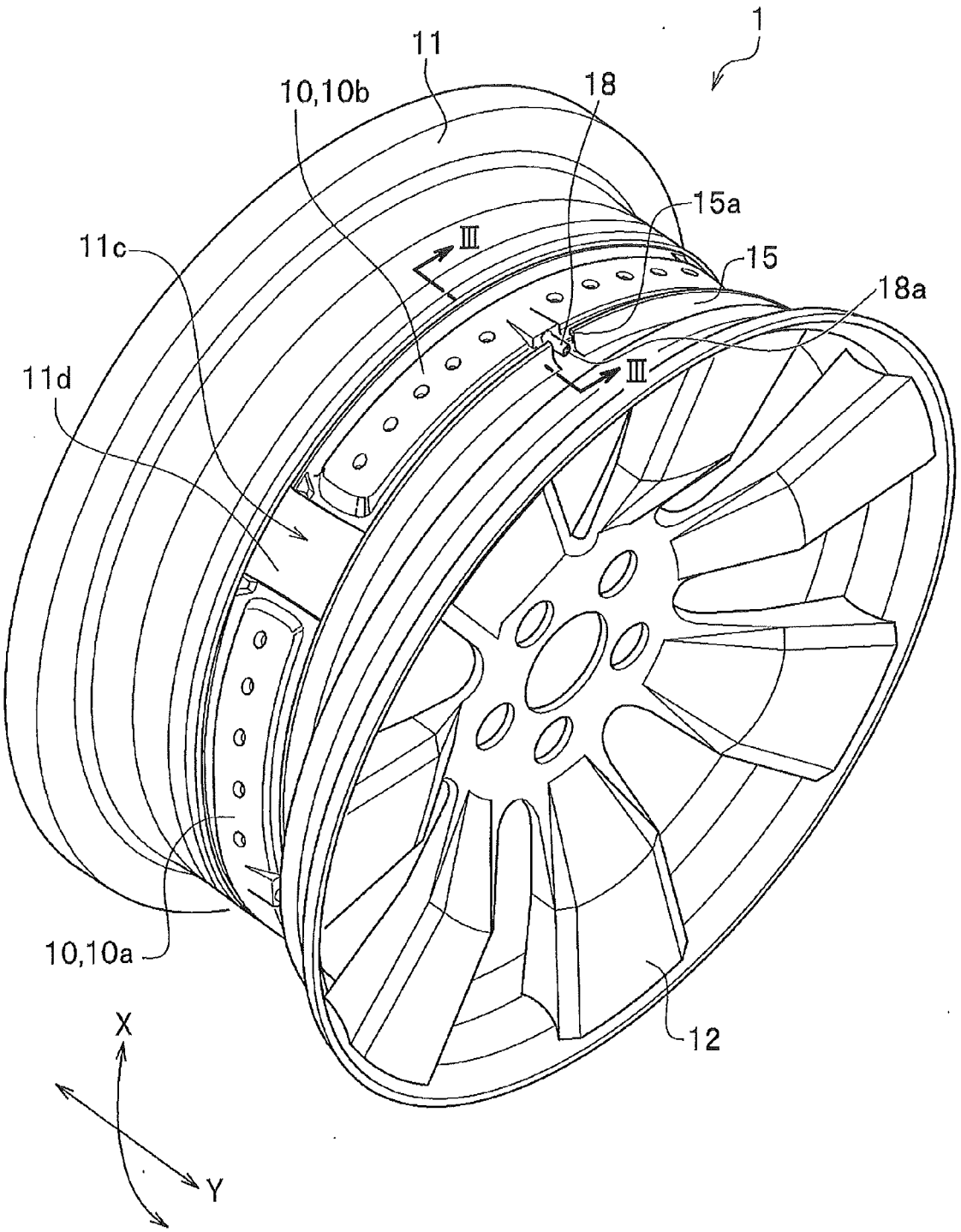


FIG.2A

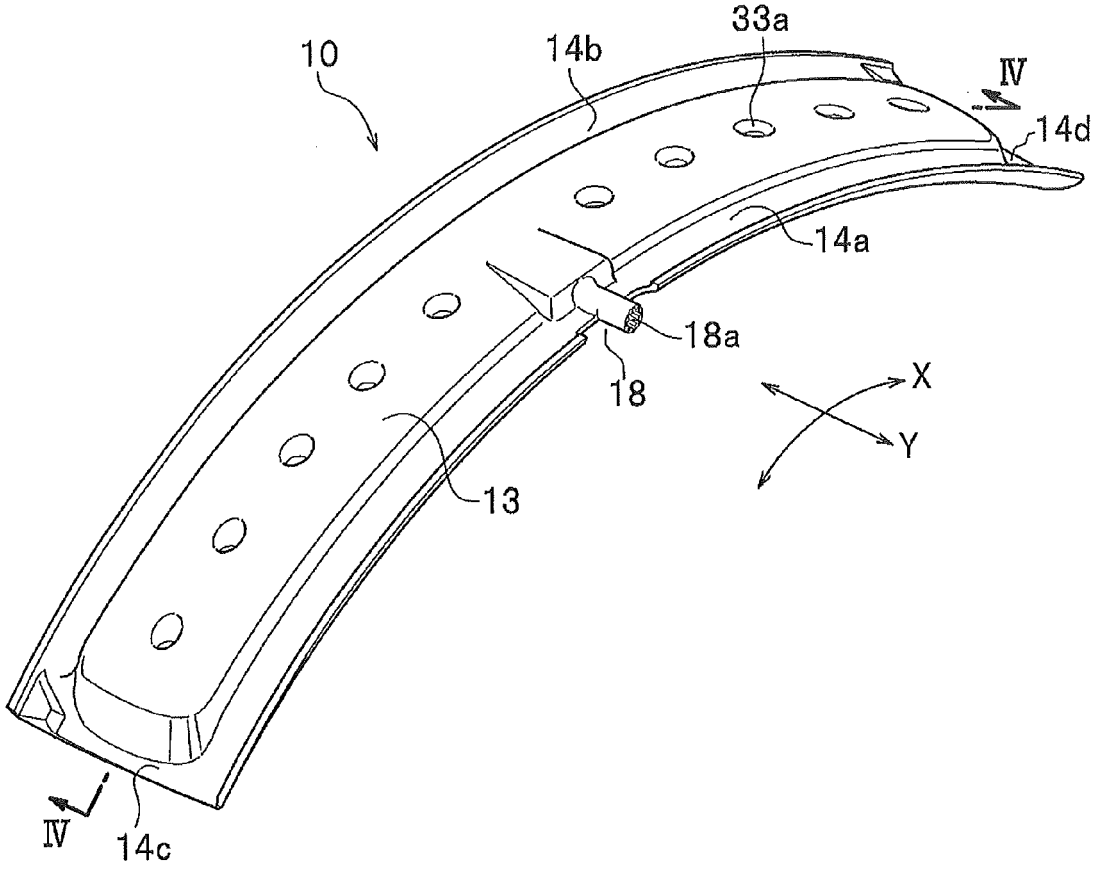


FIG.2B

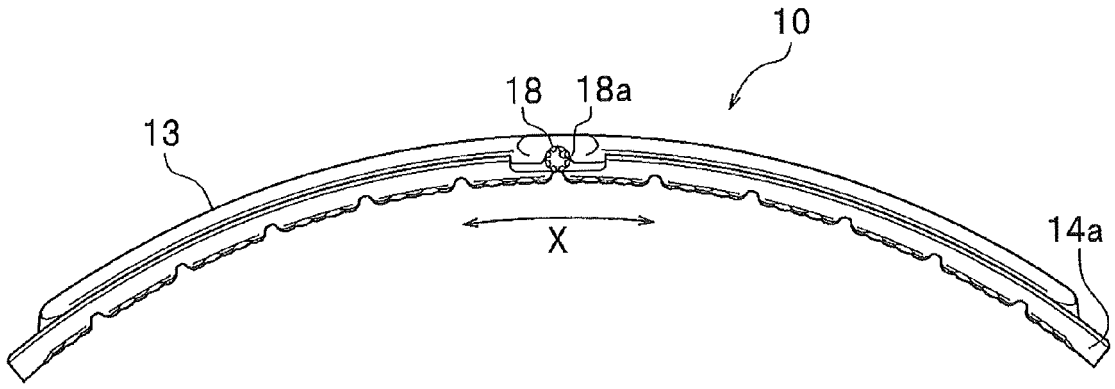
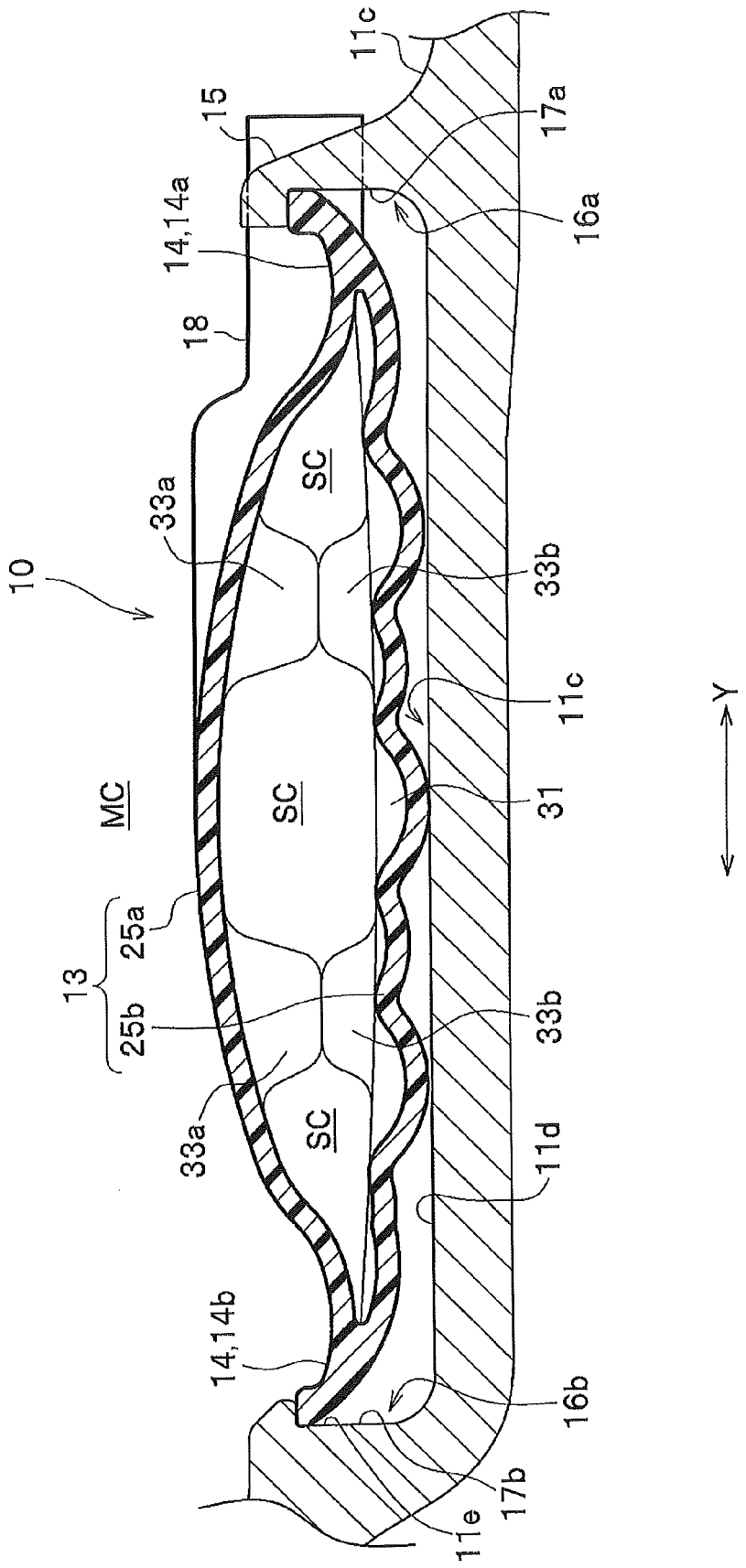


FIG.3


10
11c
15
17a
14,14a
16a
18
33a
SC
33b
11c
MC
SC
31
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25a
25b
33b
33a
SC
11d
14,14b
16b
17b
11e
Y

FIG.4

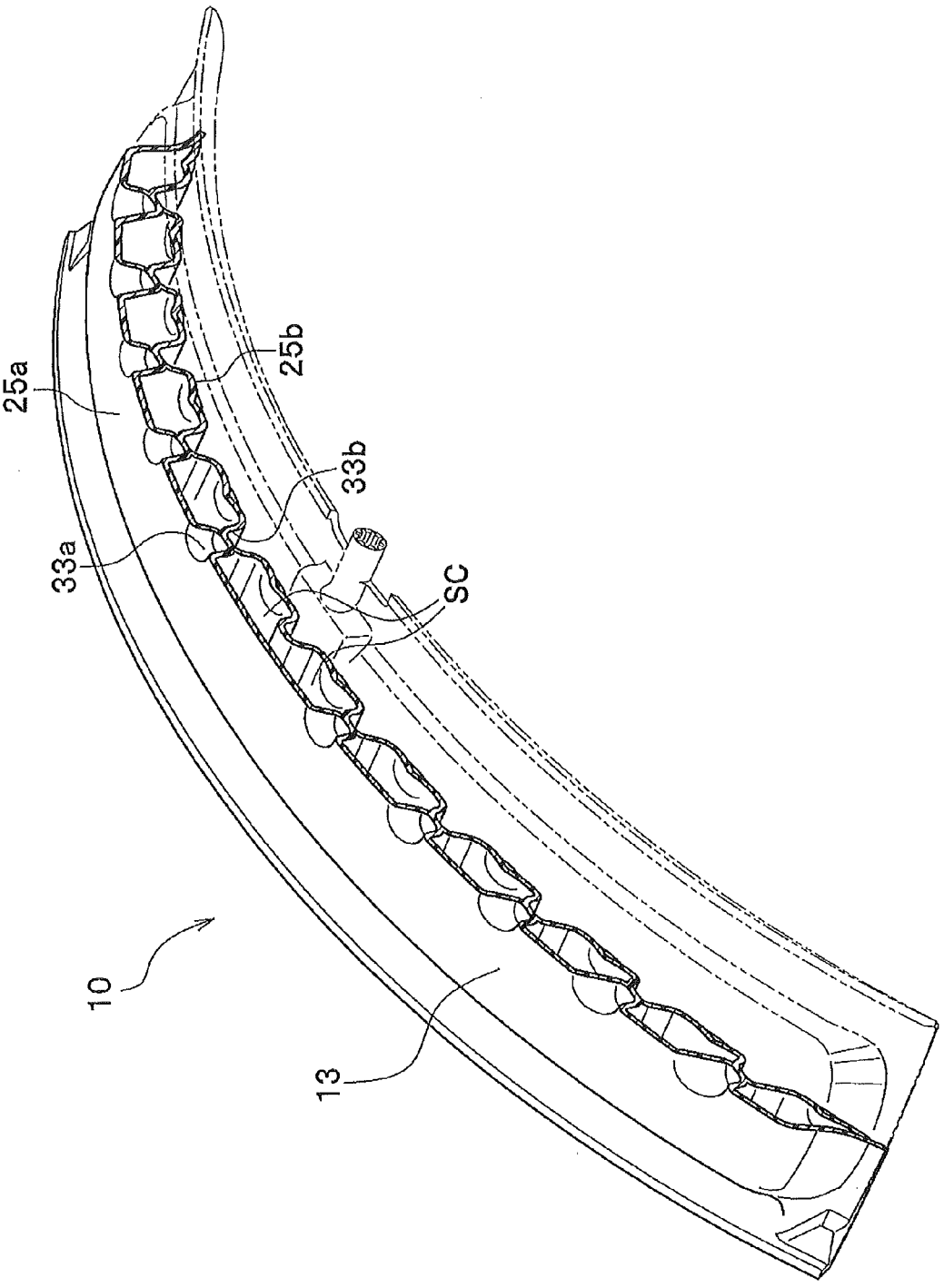


FIG.5A

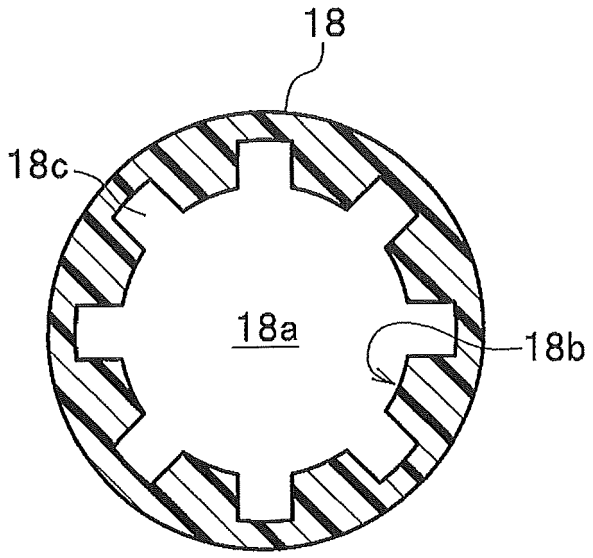


FIG.5B

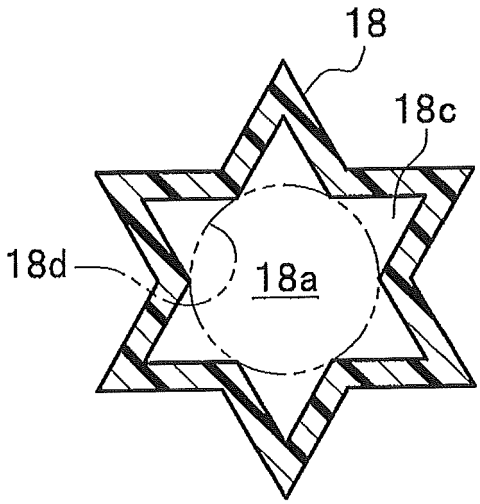
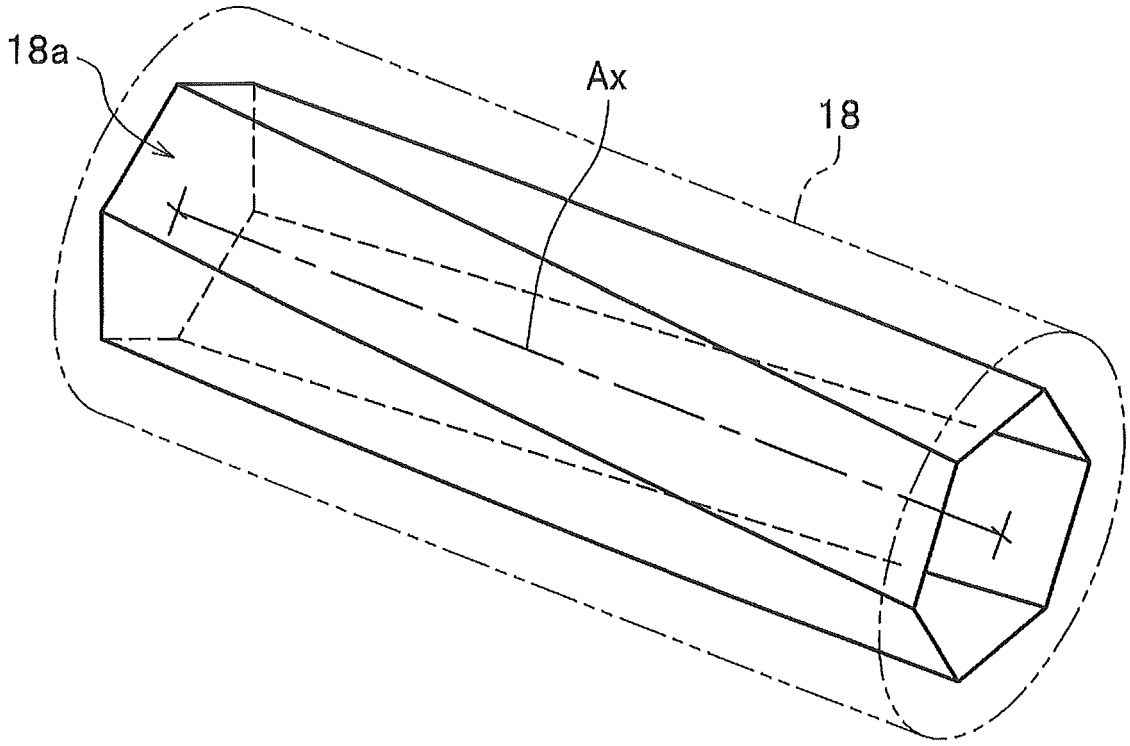


FIG.6



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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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